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Net Foreign Assets and International Adjustment in the United States, Japan and the Federal Republic of Germany *

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Abstract

This paper examines external adjustment in the U.S., Japan and Germany from the perspective of net foreign asset positions. It asks two questions: What are, in the long run, the determinants of net foreign asset equilibrium? and: What are, in the short run, the adjustment mechanisms sustaining that equilibrium? An analysis of postwar data produces two insights. First, using a cointegration approach, the existence of long-run net foreign asset equilibrium can be identified; in each of the G-3 countries, it is a function of demographic variables and public debt. Second, deviations from the long-run equilibrium give rise to disequilibrium feedback through domestic absorption and through other channels.

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Contents

I. Introduction

The current international environment is characterized by larger current account imbalances among major countries than at any point since the early post-war period. At present, the United States is running a current account deficit equal to about 3 percent of its Gross National Product, and Japan and the Federal Republic of Germany have current account surpluses of the same order, relative to their output levels. Moreover, current account positions of this size have persisted from 1982-83 to the present, leading to massive changes in net foreign assets and liabilities of these three countries. The United States, which was the largest net creditor country during most of the post-war period up until the early 1980s, is now estimated to be the world's largest net debtor, having net foreign liabilities of about $600 billion--larger than the net liability position of the 10 most heavily indebted developing countries combined. Over this period, Japan and Germany accumulated sizeable net foreign claims; they are now estimated to be net creditors to the extent of some $350 and $200 billion, respectively (IMF [1988], Table 32, p. 89).

Relative to their output levels such claims positions are not unprecedented--for instance, the net foreign liability position of the United States is about 7 percent of GNP, while Canada's has long exceeded 20 percent of GNP--but because of the size of the countries concerned, their importance for international credit flows, and the key role of their currencies for the international monetary system, the payments imbalances are potentially cause for concern. An important issue is whether forces exist that bring about smooth adjustment of net foreign assets to equilibrium levels, or whether instead tendencies toward increasing asset and liability positions will continue, and will be associated with instability in international credit and foreign exchange markets.

The causes of the present current account imbalances are not the subject of this paper; the extent to which they are related to the relative stance of fiscal policies in the United States, Japan and Germany since the early 1980s has been discussed extensively elsewhere. 1/ Instead, the analysis will consider stabilizing mechanisms that result both from private sector behavior and from fiscal policy. The adjustment mechanisms may include induced changes in aggregate supply or domestic absorption, either the direct result of net foreign asset accumulation, or prompted indirectly by changes in real exchange rates and interest rates.

It is useful in considering the question to distinguish between two conceptually different but interrelated issues: first, whether a long-run relationship exists between net foreign assets and other variables, and second, what short-run or medium-run adjustment mechanisms exist to bring about the long-run relationship. We specify a general model that allows for feedbacks consistent with various transmission mechanisms. In order to assess whether a long-run relationship exists, we both test whether

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1/ See for instance Knight and Masson [1988] and van Wijnbergen [1988].

deviations from alternative long-run relationships seem to reverse themselves, and examine whether some of the key short-run feedback mechanisms can be identified within a dynamic model framework. The existence of a stable long-run equilibrium and of short-run equilibrating feedback can in fact be viewed as facets of the same phenomenon (Hendry [1986], Engle and Granger [1987], and Section III below).

The model we consider is related to a number of strands in the literature. First, since Feldstein and Horioka [1980], a number of articles have considered why national saving and investment tend to be so highly correlated, and hence why current account imbalances tend to be small (though the data cited above for the three largest industrial countries modifies this judgement to some extent). We consider the stock counterpart of the above question; we are interested not only in the level of the current flows, but also in their persistence, 1/ and hence the extent they cause asset stock accumulation. Even if current accounts are small, they may still bring about large accumulations of net claims or indebtedness; we are interested in forces that would prevent this happening. 2/ The stabilizing feedbacks of asset stocks on goods and asset prices, and thence on saving and investment, may help explain the empirical regularity identified by Feldstein and Horioka.

This paper is also related to the literature on the transfer problem (see, among others, Johnson [1956] and Frenkel and Razin [1987]). That literature considers whether transfers of wealth between countries have effects on expenditure that feed back onto the current account balance, allowing the transfer to be effected without terms of trade changes. Since accumulations of net foreign claims correspond to transfers of wealth, depending on spending propensities, stabilization of foreign claims may or may not require real exchange rate changes.

Finally, in the absence of Ricardian Equivalence (Barro [1974]), the boundedness of net foreign assets as a ratio to GNP is related to whether government bonds as a ratio to GNP are bounded. Net foreign liabilities play the same role for the economy's intertemporal budget constraint as bonds for the government's budget constraint. There have been several

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1/ This issue has also been considered by Penati and Dooley [1984].

2/ It could be argued that since the net foreign asset stock includes valuation effects brought about by exchange rate movements, it will necessarily be stabilized as a ratio to domestic GNP since accumulations of assets will be associated with currency appreciation (leading to a decline in the domestic currency value of foreign claims) and decumulations of assets with currency depreciation (leading to an increase in the domestic-currency value of foreign claims). There are two problems with this argument. First, the postulated stabilizing role of valuation effects requires a country to be a net creditor in foreign currency, which is not true of all the larger industrial countries, much less developing countries. Second, there is little empirical evidence that exchange rate movements are systematically related to net foreign asset positions. The long-run behavior of net foreign claims is therefore an empirically interesting issue.

recent studies examining the empirical implications of the government's intertemporal budget constraint for the conduct of budgetary policy (Hamilton and Flavin [1986], Smith and Zin [1988], and Kremers [1989]). As in that literature, the proper question is not whether the economy ultimately satisfies its intertemporal budget constraint, but rather whether there are feedback mechanisms that operate smoothly to ensure that it is satisfied.

The plan of the paper is as follows. A theoretical model explaining net foreign asset positions is presented in Section II. This is followed by a description of the econometric methodology in Section III. The empirical results are in Section IV, and Section V concludes.

II. The Model

We begin by considering the pattern of net foreign claims in a model with optimizing consumers. In such a model, it is possible to relate the equilibrium values of variables to assumptions concerning preferences of households. We choose a framework that is general enough to allow the government's financing decisions to have real effects. In particular, we use a two-country version of the Blanchard-Yaari model (see Blanchard [1985], Buiter [1984], and Frenkel and Razin [1986]). It is shown that the equilibrium for net foreign assets depends in general on levels of output, government spending and government debt in the two countries. The discussion at the end of this section considers alternative models for the net foreign asset position that also take into account the following features: (1) endogenous capital accumulation; (2) life cycle effects on saving; (3) endogenous government policies; and (4) a risk premium that depends on the net claims position. Such models suggest that in general there are many factors that may affect the behavior of net foreign assets.

We assume that as in Blanchard [1985] consumers maximize the expected discounted present value of utility, subject to a fixed probability of death that is independent of age; this probability p is assumed to apply to the representative consumer in each country. Moreover, the birth rate is also equal to p, so that the population is stationary. 1/ Each individual's discount rate is equal to θ, both in the home country and in the foreign country. 2/ Countries are specialized in the production of one good; production is exogenous. Utility in each country is assumed to be Cobb-Douglas in the home good and the foreign good, implying constant expenditure shares. For the home country those shares are $1-\beta$ on the home good and β on the foreign good; for the foreign consumers,

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1/ It is the fact that the birth rate is positive that implies that Ricardian Equivalence does not hold; see Buiter [1988].

2/ If the rate of time preference depends on the level of utility (Uzawa [1968]), then the achievement of a steady state does not involve the restrictive condition that rates of time preferences have to be identical parameters (Obstfeld [1982]).

corresponding expenditure shares are $1-\beta^*$ and β^*. 1/ It is assumed that consumption is biased toward home goods, so that β and β^* are each less than one-half, and hence $1 - \beta - \beta^* > 0$. As in Blanchard [1985], insurance is assumed to exist, such that the insurance company inherits all the consumer's wealth upon death, in exchange for an actuarially fair insurance payment; there are therefore no bequests from parents to children. Financial wealth in the home country is held in the form of government bonds (B for the aggregate economy) and net claims on foreigners (F, assumed to be denominated in foreign currency). It is assumed for the time being that domestic and foreign bonds are perfect substitutes, so that interest parity holds between real interest rates r and r^*:

$$r = r^* + \dot{e}$$

The real exchange rate between the goods produced in the two countries, e, is endogenous.

Productivity growth is assumed to proceed at rate n in each country; as already mentioned there is no population growth, and hence outputs Y and Y^* (assumed exogenous) also expand at n (all variables are measured in real terms). Letting C, C^* equal aggregate consumption, and T, T^* equal taxes in the home and foreign countries, then under the above assumptions consumption in each country is a constant fraction of total wealth:

$$C = (\theta+p)\ [H + B + eF] \qquad C^* = (\theta+p)\ [H^* + B^* - F] \tag{1}$$

where human wealth levels H, H^* are given by

$$\dot{H} = (r+p)H - (Y - T) \qquad \dot{H}^* = (r^* + p)H^* - (Y^* - T^*) \tag{2}$$

Goods market equilibrium requires that output is equal to the sum of domestic and foreign consumption and government spending; each government is assumed for convenience only to buy domestic goods, in amounts G, G^*, respectively. 2/ So goods market clearing requires

$$Y = (1-\beta)C + G + \beta^* eC^* \qquad Y^* = (1-\beta^*)C^* + G^* + \beta C/e \tag{3}$$

The change in the net foreign asset position is equal to the current account balance, that is, to foreign purchases of home goods, minus home purchases of foreign goods, plus investment income receipts from abroad (or payments, if F is negative). Recall that these claims or liabilities are assumed to be denominated in the foreign country's currency and hence to pay rate r^*, equal to the rate paid on the debt of the foreign government. Hence the change in net foreign assets is given by

$$\dot{F} = \beta^* C^* - \beta C/e + r^* F \tag{4}$$

1/ Throughout this section, starred symbols refer to the foreign country.

2/ This can easily be generalized.

Government budget constraints relate the change in bond stocks to government spending, taxes, and real interest rates:

$$\dot{B} = rB + G - T \qquad \dot{B}^* = r^*B^* + G^* - T^* \tag{5}$$

As noted above, we consider the case where outputs in the two countries grow at the same rate n; we assume that the interest rates r, r^* exceed that growth rate in equilibrium. 1/ We further assume that, in equilibrium, government spending grows at the same rate as output, as do taxes and the public debt. We then examine the long-run equilibrium for net foreign assets, assuming first that a steady state exists with constant interest rates and real exchange rate, and where asset stocks grow at the same rate as output. The stability of such an equilibrium is subsequently discussed.

The existence of a steady state presupposes a constant real exchange rate; interest parity therefore implies that $r = r^*$ in steady state. With constant interest rates and constant growth rates for income and taxes, human wealth is given by the following:

$$H = (Y - T)/(r+p-n) \qquad H^* = (Y^* - T^*)/(r+p-n) \tag{6}$$

therefore, if $\dot{F} = nF$, we can solve for F using (1) and (4). This yields

$$F = - [r-n - (\beta^*+\beta)(\theta+p)]^{-1}\{\beta^*(\theta+p)[(Y^*-T^*)/(r+p-n) + B^*] - \beta(\theta+p)[(Y-T)/(r+p-n)+ B]/e\} \tag{7}$$

The equilibrium level for r can be obtained by summing the goods market equilibrium conditions (3), with the second equation multiplied by the equilibrium exchange rate e. Writing the resulting world variables $\overline{Y} = Y + eY^*$, etc., yields

$$\overline{Y} = (\theta+p)[(\overline{Y} - \overline{T})/(r+p-n) + \overline{B}] + \overline{G} \tag{8}$$

Assuming that $\dot{B} = nB$, we can use the government budget constraint, summed for the two countries, to solve for $\overline{T}$, namely,

$$\overline{T} = \overline{G} + (r-n)\overline{B} \tag{9}$$

Substituting (9) into (8), we can solve for r:

$$r = n + \theta + (\theta+p)p\overline{B}/(\overline{Y} - \overline{G}) \tag{10}$$

Thus, when either world government debt $\overline{B}$ or the probability of death p is zero, the real interest rate equals $n + \theta$; when debt and p are positive, the real interest rate is higher, by an amount that is

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1/ If this is not the case, then the government could borrow unlimited amounts and yet be able to repay the interest when it came due from increased tax revenue. For empirical evidence, see Abel et al. (1986).

increasing in the ratio of debt to world output net of government spending. 1/

Using the expression for the equilibrium interest rate, we can derive expressions for the steady state exchange rate and net foreign asset position. First define $\delta = [1 + p\bar{B}/(\bar{Y}-\bar{G})]^{-1}$. Substituting the expressions for consumption, (1), and equilibrium human wealth, (6), and the government budget constraint, (5), into one of the pair of equations (3), say the first one, yields

$$[F(\theta+p)(1-\beta-\beta^{*}) + \beta^{*}\delta(Y^{*}-G^{*}+pB^{*})]e = Y - G - (1-\beta)\delta(Y-G+pB) \qquad (11)$$

Equation (11) corresponds to goods market equilibrium. It gives the combinations of e and F such that home-country output is equal to demand; an increase in F, on the assumption that consumption is biased towards domestic goods so $1-\beta-\beta^{*}>0$, raises the relative demand for home goods. Therefore, it is associated with a real appreciation (a decrease in e).

Next, equation (7) gives an expression for asset market equilibrium:

$$-\{(\theta+p)[\delta^{-1}-\beta-\beta^{*}] - p\}F = \beta^{*}\delta(Y^{*}-G^{*}+pB^{*}) - \beta\delta(Y-G+pB)/e \qquad (12)$$

Equation (12) corresponds to equality between the current and capital accounts. Together, equations (11) and (12) determine equilibrium net foreign assets and the real exchange rate.

After considerable manipulation, it can be shown that the home country's net foreign claims as a ratio to its output in steady state are given by

$$eF/Y = \delta\,\frac{[(1-G/Y)\bar{B}/\bar{Y}-(1-\bar{G}/\bar{Y})B/Y]}{p[1-\bar{G}/\bar{Y}-(\theta+p)\bar{B}/\bar{Y}]} = \delta\,\frac{[(1-G/Y)\bar{B} - (\bar{Y}-\bar{G})B/Y]}{p[\bar{Y}-\bar{G}-(\theta+p)\bar{B}]} \qquad (13)$$

The denominator of the RHS of (13) is positive, for reasonable levels for the variables. 2/ Therefore, the sign of F is the same as the sign of the numerator of (13), and higher domestic government spending and debt are associated with lower net claims on foreigners (keeping world totals unchanged) and conversely for foreign country variables.

The stability of the model will not be analyzed here; it has been treated by Buiter [1984]. He shows that a more complicated version of the model that includes capital accumulation is saddlepoint stable, for plausible parameter values and assuming adjustment of taxes to satisfy the government's intertemporal budget constraint. Given that the model is stable, it can be expressed as adjustment equations toward a steady state

1/ This is essentially the result for the closed economy given in Buiter [1988, p. 288, eq. 31].

2/ Note that the real interest rate minus the real growth rate (i.e., r - n) is at least equal to θ + p. A positive value for the denominator is thus necessary for the government's relative claim to output (in the form of government spending and net interest cost) not to exceed unity.

growth path which, in the case of F, H, and H^*, involves growth at rate n. Scaling eF and H by Y, and H^* by Y^*, gives variables that are stationary in steady state. If we call the resulting ratios f, h and h^*, and their equilibrium levels $\hat{f}$, $\hat{h}$ and $\hat{h}^*$, respectively, and if the equilibrium level of the exchange rate is denoted by $\hat{e}$, then the model can be linearized around those equilibrium values to give the following fourth-order system:

$$\begin{bmatrix} \dot{f} \\ \dot{h} \\ \dot{h}^* \\ \dot{e} \end{bmatrix} = A \begin{bmatrix} f - \hat{f} \\ h - \hat{h} \\ h^* - \hat{h}^* \\ e - \hat{e} \end{bmatrix} \tag{14}$$

The matrix A has three negative and one positive characteristic roots, in keeping with saddlepoint stability. The error-correction models discussed in Section IV estimate discrete-time versions of a subset of (14). 1/

There are several theoretical extensions of the above model that may be of empirical relevance. First, production and investment can be made endogenous. Current account surpluses and deficits correspond not just to consumption smoothing but also result from investment flowing to its most productive uses. Long-run net foreign asset positions then result from cumulative investment flows in excess of domestic saving.

Second, equilibrium net foreign asset positions have also been considered in a framework that takes account of the age structure of the population. In a model with two overlapping generations, it can be shown that the country whose residents have a higher value of consumption when young will run a steady-state current account deficit, and thus will be a net debtor in equilibrium (Buiter [1981]). Persson [1985] shows in a two-country, one-good version of that model that net foreign assets will be affected by government debt in substantially the same way as described above. More generally, life-cycle models (see Ando and Modigliani [1965]) posit that saving varies over a person's life for such reasons as accumulating down-payments on a house and saving for children's education or retirement. Such a model would suggest that aggregate saving, and perhaps also the current account and net foreign asset positions could depend on the age structure of a country's population. Lee and Lapkoff [1988] consider the effects of increased fertility--implying an age structure with proportionately more young people--on intergenerational transfers and consumption. They conclude that higher fertility would lower life cycle consumption, though this is the net result of several effects with different signs, all of which subject to a "considerable range of uncertainty."

1/ We do not attempt to model the variable that "jumps" in order to reach a stable adjustment path (the exchange rate).

Third, the possibility that government policies are modified in order to influence the net foreign asset position may have to be taken into account. For instance, Summers [1988] argues that the apparent immobility of capital may be due to policies of governments that aim to restrict international investment positions, and that a reason they may want to do so is that the social return to domestic investment exceeds that of foreign investment. Governments may choose to impose capital controls or taxes; it may also be the case that budgetary positions are influenced by targets for net national saving.

Fourth, interest parity may be violated because domestic and foreign bonds are not perfect substitutes, as a result of currency risk or country risk. There may therefore be a systematic portfolio balance relationship between interest differentials and net foreign asset positions in the long run. As an example, Dooley and Isard [1986] have recently argued that fear of taxation helps to explain why large net claims positions are not allowed to develop, despite favorable investment opportunities.

To sum up, the model suggests that there should be a long-run relationship between ratios to GNP of net foreign assets, government spending, and government debt. In the empirical part of the paper, we first examine the net foreign assets ratio to see whether it exhibits stability over time. We then attempt to relate its secular movement to the government variables mentioned above, and to demographic variables.

The model also suggests that the dynamic feedbacks allowing net foreign assets to maintain a stable pattern may be complex. Possible linkages include the following:

(1) An increase in F changes home and foreign wealth, changing expenditure patterns; given the bias of consumption towards domestic goods, this leads to an increase in the relative demand for the home goods.

(2) Changes in F will be associated with changes in the value of the real exchange rate needed to maintain goods market equilibrium, leading to expenditure switching.

(3) If a portfolio balance relationship exists, then changes in F will affect interest differentials directly, which will also feed back onto exchange rates and expenditure.

These feedbacks may operate with a lag, especially in a model where the accumulation of physical capital is taken into account. Therefore, the dynamics of adjustment may be quite complex. In the empirical part of the paper, Section IV, we attempt to identify some of these feedbacks by estimating dynamic adjustment equations for net foreign assets and for domestic absorption. In each case, we test whether the deviations from the long-run equilibrium net foreign asset ratio (discussed above) have significant feedback effects.

III. Econometric Methodology

The purpose of the empirical analysis is first to identify the existence of possible stabilizing mechanisms that ensure a long-run equilibrium of the ratio of net foreign assets to GNP. As we have seen above, this equilibrium could be a function of other variables, including the ratio of government debt to GNP. Given that some of these variables may appear to be non-stationary, that is, not to settle down to a constant value, particularly in the small post-war sample, 1/ the concept of cointegration offers a suitable framework for the empirical analysis.

Cointegration allows one to study the behavior of variables moving apart in the short run, but brought together again to a stationary equilibrium by government policy or market forces, or both, in the long run. A variable is defined to be integrated of order one [denoted by I(1)] if it must be differenced once to induce stationarity [denoted by I(0)]. 2/ A set of variables, each I(1), is said to be cointegrated if a linear combination of them is I(0) (i.e., if they "move together in the long run"). That linear combination is characterized by a cointegrating vector.

The empirical analysis in the next section starts by testing whether the ratio of net foreign assets to GNP is stationary; such stationarity would indicate the existence of a long-run equilibrium as a function of stationary variables only. 3/ In the event that non-stationarity of this ratio cannot be rejected, it will subsequently be assessed whether the ratio is cointegrated with other non-stationary variables suggested by the theoretical considerations presented in the previous section. Such cointegration would suggest that the arguments of the long-run equilibrium also included these other non-stationary variables.

Given the small sample, it is evidently important to follow an approach to testing that has high power to reject non-stationarity. The remainder of this section explains the testing strategy adopted below. Two alternative approaches to testing for cointegration have been proposed by Engle and Granger [1987]. One strategy consists of applying the usual univariate tests for (unit root) non-stationarity to deviations of the data from a long-run cointegrating combination. The other involves testing for the presence of equilibrating feedback in the context of a multivariate dynamic specification. It has been established that the latter approach tends to be more powerful (Banerjee et al. [1986], Engle and Granger [1987]). Therefore, graphical evidence will be examined and univariate tests will be applied, but only as a first step of the

1/ Even using the combined inter- and post-war sample, Kremers [1989] finds it difficult to reject non-stationarity of the ratio of U.S. Federal debt to GNP.

2/ Provided the variable has no deterministic component. See Granger [1986], Hendry [1986], and Engle and Granger [1987] for introductions to cointegration.

3/ Since any linear combination of I(0) variables remains itself I(0).

empirical analysis; the results of this first step will subsequently be scrutinized within a dynamic framework.

1. Univariate tests

Following the first approach, a variable $\hat{u}_t$, representing deviations of the ratio of net foreign assets to GNP from its long-run equilibrium, will be tested for non-stationarity. Suppose that the long-run equilibrium ratio for net foreign assets depends on a constant term and the ratio of government debt to GNP (B/Y), with estimated coefficients $\hat{c}_0$ and $\hat{c}_1$, respectively. 1/ Then

$$\hat{u}_t = (F/Y)_t - \hat{c}_0 - \hat{c}_1 (B/Y)_t$$

Several tests for non-stationarity were discussed by Engle and Granger [1987], who found that the finite-sample properties of the tests tend to be quite sensitive with respect to the characteristics of the underlying data-generation process. Therefore, we shall apply two alternative tests that have different power properties and compare their conclusions.

2. Multivariate dynamic models

As a basis for the second approach to testing for cointegration, Engle and Granger [1987] established that cointegration is necessary and sufficient for the existence of a dynamic error-correction model. Hence, we shall estimate error-correction models of the form:

$$\Delta(F/Y)_t = a_1\hat{u}_{t-1} + \text{short-run dynamics } [(I(0)]$$

and test whether a_1 is significantly negative. 2/ In terms of the theoretical analysis, this corresponds to testing whether certain elements of the matrix A in equation (14) in Section II differ from zero, and thereby provides useful information about the respective roles of different feedback mechanisms as discussed further below. The error-correction model will thus be the discrete-time version of part of the dynamic model derived in the theoretical section.

1/ As mentioned above, tests for non-stationarity will first be applied directly to the ratio of net foreign assets to GNP; this is evidently equivalent to including only the constant term in the cointegrating vector. We also perform tests with additional variables (in particular, demographic variables) in the cointegrating vector.

2/ Monte Carlo evidence, for instance in Engle and Granger [1987], suggests that under the null hypothesis of no cointegration the t-statistic on the error-correction variable may not have the usual asymptotic distribution. However, Banerjee et al. [1986] obtain Monte Carlo results indicating that, at the 5 percent level, the t-test may have about the correct size.

IV. Empirical Results

1. The long run

The post-war pattern of the ratio of net foreign assets to GNP for the United States, Japan and Germany is shown in Chart 1. 1/ The graphical evidence suggests no sustained tendency on the part of any of these ratios to return to a stationary long-run equilibrium. The net foreign asset positions of Japan and Germany, relative to GNP, have fluctuated along an upward trend, while, in contrast, that of the United States has fallen dramatically in the 1980s after following a more stable pattern in the previous decades.

The graphical impression is confirmed by the fact that, for this sample, non-stationarity of the F/Y ratio cannot be rejected for any of the three countries (Table 1). However, the non-stationarity of the first difference of this variable can be rejected, indicating that F/Y is I(1). 2/ Hence, if a stationary long-run equilibrium exists, then it must be a function of at least one other non-stationary variable.

In order to explore this possibility, we examine the cointegration of F/Y with government debt stocks and demographic variables. The theoretical analysis of Section II suggests that, in equilibrium, higher net foreign assets (scaled by GNP) would be associated with lower government debt at home and higher government debt abroad (equation (13)). Given that comparable data on government debt is not available for a reasonably large number of industrial countries over the time period of interest to us, we focus on the possible cointegration of F/Y with the domestic debt-to-GNP ratio. 3/ The two demographic variables included in the analysis are the foreign ratio of the population aged under 15 years to that from 15 to 64 years, divided by the corresponding ratio for the home country (RDEM1), and an analogous ratio for the population aged 65 years and over (RDEM2).

The first step is to ascertain that all these variables are indeed I(1). The non-stationarity of B/Y cannot be rejected but that of Δ(B/Y) can be (Table 1), confirming that B/Y is I(1). 4/ But, for the sample under investigation, each of the demographic variables appears to be I(2). Still, the finding that, for each of the three countries, a linear combination of the pair of relative demographic variables seems to be

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1/ Data sources are given in Appendix I.

2/ The test result for the United States is sensitive to inclusion of data describing its dramatic swing into a net debtor position in the 1980s.

3/ Another variable that emerged in the theoretical model--the ratio of government spending to GNP--seems to be I(0), and hence should not appear in the cointegrating equation. Domestic government spending ratios were included in the dynamic equations; however, they did not seem to play any significant role.

4/ Albeit only at a rather high significance level in the case of Japan.

Table 1. Tests for Order of Integration 1/

Variable	Sargan-Bhargava Result	Sargan-Bhargava Sample	Augmented Dickey-Fuller 2/	Inference
United States				
F/Y	0.20	1950-86	-0.03	F/Y at least I(1).
Δ(F/Y)	0.42	1951-86	-0.50	?
F/Y	0.28	1950-81	-0.03	F/Y at least I(1).
Δ(F/Y)	1.28*	1951-81	-3.56*	F/Y is I(1).
B/Y	0.05	1950-87	-1.50	B/Y at least I(1).
Δ(B/Y)	0.74*	1951-87	-5.74*	B/Y is I(1).
RDEM1	0.06	1956-86	-2.55	RDEM1 at least I(1).
Δ(RDEM1)	0.20	1957-86	-1.78	RDEM1 at least I(2).
ΔΔ(RDEM1)	2.17*	1958-86	-5.62*	RDEM1 is I(2).
RDEM2	0.02	1956-86	-1.64	RDEM2 at least I(1).
Δ(RDEM2)	0.39	1957-86	-1.96	RDEM2 at least I(2).
ΔΔ(RDEM2)	2.02*	1958-86	-5.18*	RDEM2 is I(2).
Japan				
F/Y	0.06	1954-86	-0.76	F/Y at least I(1).
Δ(F/Y)	1.26*	1955-86	-3.82*	F/Y is I(1).
B/Y	0.03	1954-86	-0.68	B/Y at least I(1).
Δ(B/Y)	0.51	1955-86	-2.03	B/Y is I(1)?
ΔΔ(B/Y)	2.56*	1956-86	-7.07*	B/Y is I(1)?
DEM1	0.06	1956-86	-4.28*	?
Δ(RDEM1)	0.21	1957-86	-1.42	RDEM1 at least I(2).
ΔΔ(RDEM1)	2.17*	1958-86	-5.56*	RDEM1 is I(2).
RDEM2	0.02	1956-86	-2.78	RDEM2 at least I(1).
Δ(RDEM2)	0.34	1957-86	-2.77	RDEM2 at last I(2).
ΔΔ(RDEM2)	2.88*	1958-86	-8.17*	RDEM2 is I(2).

Table 1 (continued). Tests for Order of Integration 1/

Variable	Sargan-Bhargava Result	Sargan-Bhargava Sample	Augmented Dickey-Fuller 2/	Inference
Germany				
F/Y	0.18	1955-86	-2.11	F/Y at least I(1).
Δ(F/Y)	1.04*	1955-86	-3.08*	F/Y is I(1).
B/Y	0.04	1955-86	0.13	B/Y at least I(1).
Δ(B/Y)	0.89*	1955-86	-3.19*	B/Y is I(1).
RDEM1	0.04	1956-86	-3.84*	?
Δ(RDEM1)	0.12	1957-86	-1.83	RDEM1 at least I(2).
ΔΔ(RDEM1)	1.13*	1958-86	-2.95*	RDEM1 is I(2).
RDEM2	0.04	1956-86	-2.47	RDEM2 at least I(1).
Δ(RDEM2)	0.19	1957-86	-1.11	RDEM2 at least I(2).
ΔΔ(RDEM2)	1.76*	1958-86	-4.60*	RDEM2 is I(2).

Source: Appendix I.

1/ This table reports tests for non-stationarity of the variables included in the cointegration tests. The tests are the Sargan-Bhargava (SB) statistic, with critical values in Sargan and Bhargava [1983, Table I] and Bhargava [1986, Table I] and the Augmented Dickey-Fuller (ADF) statistic, with critical values in Fuller [1976, Table 8.5.2]. Statistics suggesting rejection of non-stationarity at the 5 percent significance level are marked by an asterisk (*). The ADF auxiliary test regressions (not reported) were checked for the absence of autocorrelation.

2/ The sample for each of the ADF tests equals that for the corresponding SB test, minus the observations at the beginning of the sample needed to obtain the number of lags necessary for an ADF test regression without residual autocorrelation.

I(1), justifies including them jointly in a cointegrating combination with other I(1) variables (F/Y and B/Y). 1/

The tests for cointegration of the set of variables comprising F/Y, B/Y, RDEM1, and RDEM2 are presented in Table 2. In the cases of Japan and Germany, the ADF tests reject the null hypothesis of no cointegration at a significance level of 5 percent (for Germany, the regression includes a trend term as well); for the United States the significance level is somewhat higher. In all three cases the SB test statistics lie in the 5 percent inconclusive region, but, given the relatively large number of variables included, this region is very wide. Taken together, this evidence suggests that, for the three countries under investigation, a stationary long-run equilibrium for the F/Y ratio exists, and that it is a function of B/Y and demographic factors. Of course, as mentioned in Section III, the equilibrium may depend on one or more I(0) variables as well--this will be examined in the dynamic analysis.

Even though the coefficient estimates obtained from the static regressions in Table 2 are biased (given the autocorrelation induced by the absence of dynamics and other explanatory variables), they are consistent 2/ and it is therefore noteworthy that the coefficients on B/Y are of the hypothesized sign. In addition, they are of very similar magnitude for Japan and Germany, while the coefficient for the United States is twice as large in magnitude. As regards the influence of demographic variables, it appears that, for the United States and Japan, relatively high average age of the population corresponds to high net foreign assets; this result seems consistent with Lee and Lapkoff [1988], cited above. However, for Germany the relation appears to be the reverse.

In order to help understanding of the implications of the estimated equation for long-run equilibrium of the ratio of U.S. net foreign assets to GNP, we present actual and fitted values, given in Chart 2. It appears that this equilibrium, which is conditional on the paths of B/Y and the demographic variables, and which assumes that any possible I(0) influences are zero, sharply declined in the 1980s. According to the estimated coefficients, this primarily reflected the change in stance of U.S. fiscal policy, as evidenced by Chart 3 which decomposes the hypothetical long-run equilibrium into the relative contributions of the debt and demographic variables. During the 1950s and the 1960s, a fairly stable F/Y ratio was the result of offsetting forces: a declining debt-to-GNP ratio and a more rapidly aging population than in other countries. Both the B/Y ratio and

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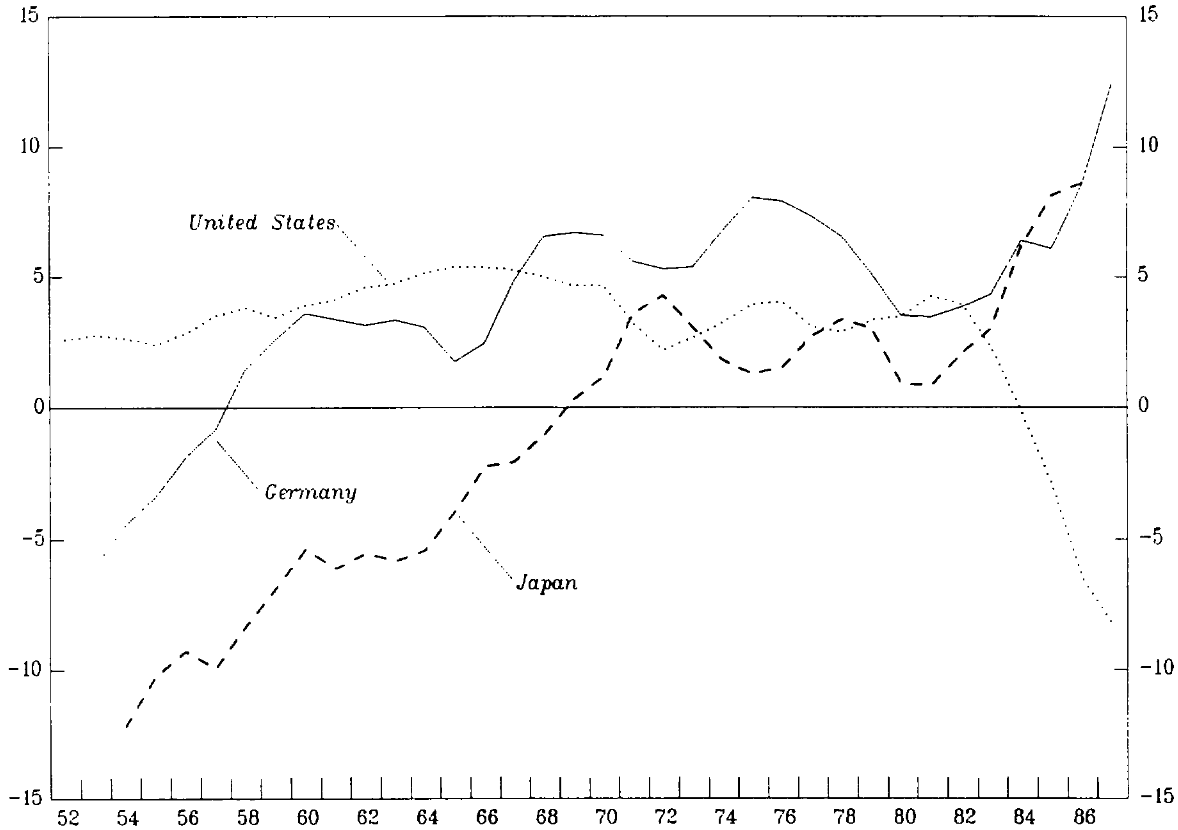
1/ For the United States, Japan and Germany, the SB statistics testing for cointegration of ΔRDEM1 and ΔRDEM2 (including a constant term) are 0.57, 0.98, and 0.99, respectively. The corresponding ADF statistics are -2.28, -3.06, and -3.02. These results are consistent with cointegration at a significance level of 10 percent for Japan and Germany, but at a higher level for the United States (sources for the critical values are given in footnote 1 of Table 2).

2/ They are in fact super-consistent, i.e., they converge to the true parameters at a faster-than-normal rate (Banerjee et al. [1986]).

Chart 1. Net Foreign Assets (Percent of GNP), 1952 to 1987[1]

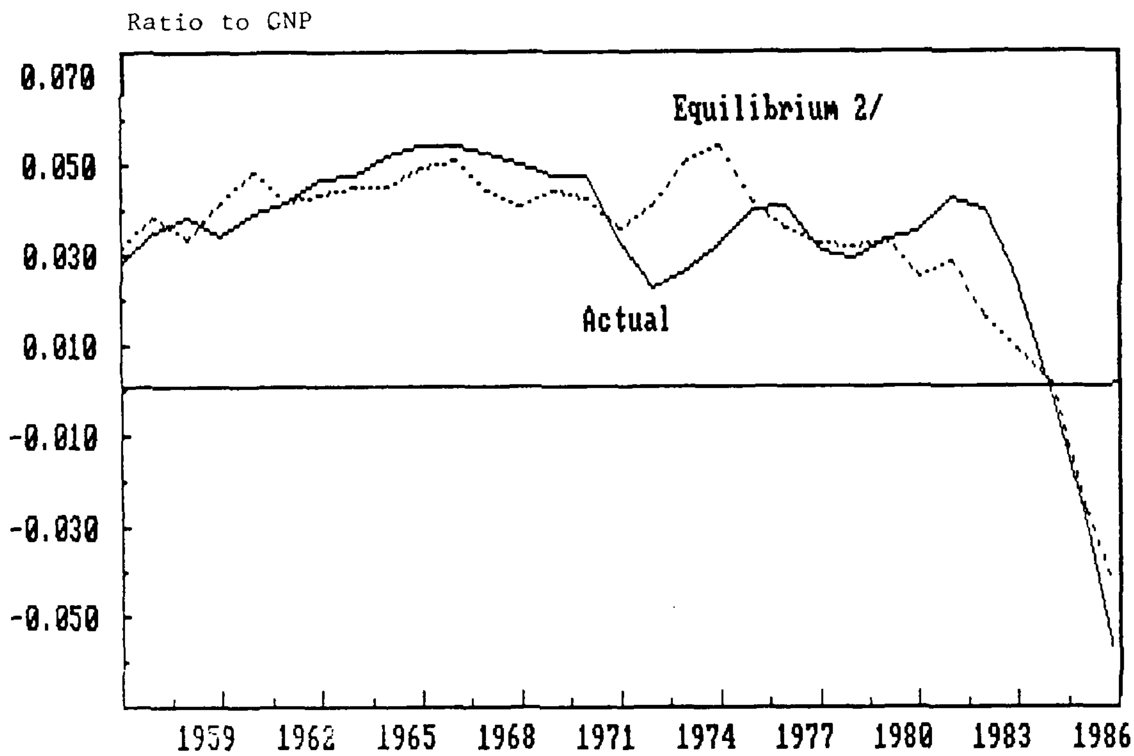


[1] Source: See Appendix; Data for Japan and Germany begin in 1954 and 1953 respectively, data for Japan end in 1986.

Chart 2

UNITED STATES

Actual and equilibrium values of net
foreign assets, 1956-86 1/



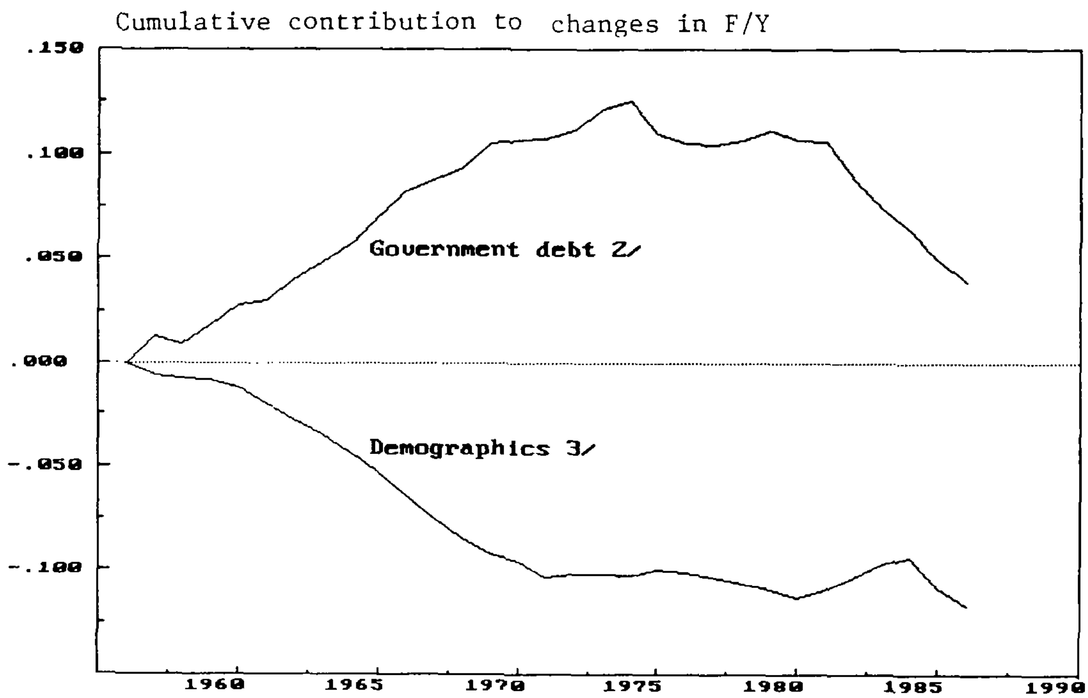
Source: Appendix I and Table 2.

1/ Conditional on demographics and the ratio of government debt to GNP.
2/ Coefficients are in Table 2; determinants are in Chart 3.

Chart 3

UNITED STATES

The determinants of net foreign asset
equilibrium, 1956-86 1/



Source: Table 2.

1/ This chart shows the contribution of demographics and government debt to changes since 1956 in the conditional net foreign asset equilibrium depicted in Chart 2.

2/ B/Y multiplied by its coefficient from Table 2, shifted so that 1956=0.

3/ Linear combination of RDEM1 and RDEM2 using the coefficients from Table 2, shifted so that 1956=0.

Table 2. Cointegration Tests 1/

Variables included in regression					Sargan-	Augmented
Constant	B/Y	RDEM1	RDEM2	TREND	Bhargava	Dickey-Fuller
United States						
0.62 (0.06)	-0.44 (0.05)	0.46 (0.08)	-0.87 (0.09)		0.62 2/	-3.51
Japan						
0.43 (0.06)	-0.21 (0.06)	0.18 (0.02)	-0.39 (0.03)		0.94 2/	-4.22*
Germany						
-0.076 (0.086)	-0.19 (0.15)	-0.22 (0.14)	0.49 (0.31)	0.004 (0.001)	0.67 2/	-4.63*

Source: Appendix I.

1/ This table reports static OLS regressions of the ratio of net foreign assets to GNP (F/Y) on: a constant; the ratio of government debt to GNP (B/Y); the foreign ratio of the population aged under 15 years to that from 15 to 64 years relative to the corresponding ratio in the home country (RDEM1); the foreign ratio of the population aged 65 years and over to that aged from 15 to 64 years relative to the corresponding ratio for the home country (RDEM2); and, for Germany, a trend term. The data are annual for the period 1956-86. The tests for non-stationarity of the residuals from these regressions are given by the Sargan-Bhargava test statistic, with critical values in Sargan and Bhargava [1983, Table I] and the Augmented Dickey-Fuller statistic, with critical values in Engle and Yoo [1987, Table 3]. Statistics suggesting rejection of non-stationarity at the 5 percent significance level are marked by an asterisk (*). The ADF auxiliary test regressions (not reported) were checked for the absence of autocorrelation. For further explanations, see Table 1.

2/ Test result lies in the 5 percent inconclusive region of Sargan and Bhargava [1983, Table I]. Given the large number of regressors, these regions are very wide.

the combined effect of demographic factors stabilized in the 1970s, but in the 1980s large Federal deficits had the effect of rapidly increasing the government's indebtedness. In the absence of counterbalancing movements in demographic variables, the implied equilibrium for net foreign assets became strongly negative. Since the equation overpredicts at the end of the period, the actual net foreign asset position of the United States in 1986 was even more negative than this conditional long-run equilibrium would imply.

In contrast, the long-run equilibrium of the Japanese net foreign asset position has shown an upward movement throughout most of the post-war period (Chart 4), reflecting the aging of the population in combination, after the mid-1970s, with fiscal consolidation (Chart 5). In 1986, its net foreign asset position lay above this hypothetical equilibrium.

In Germany, before the mid-1970s the debt and demographic variables made virtually no contribution to the rising net foreign asset equilibrium (Charts 6 and 7), the rise reflecting other influences which are proxied by the trend term. 1/ From the mid-1970s onward, however, the net foreign asset equilibrium showed a downward movement as the government budget turned into deficit and the average age of the German population rose slightly relative to other countries. More recently, the government has stabilized B/Y and the net foreign asset equilibrium has resumed its upward path.

Of course, given the relatively small sample upon which the static regressions are based, the implications for long-run equilibrium of net foreign asset positions should be interpreted with caution. Nevertheless, the dynamic analysis does provide strong supporting evidence.

2. The dynamics

The purpose of this sub-section is two-fold. First, dynamic error correction models are estimated in order to scrutinize in a more powerful fashion the conclusions regarding long-run foreign asset equilibrium reached above. Second, by estimating these models some light is shed on the dynamic forces underlying the long-run equilibrium, i.e., the adjustment mechanisms discussed in Section II.

The conceptual background for the dynamic analysis is equation (14) of the theoretical model, which expresses foreign assets and other variables as adjusting toward the long-run steady-state equilibrium. Rather than estimating a complete reduced-form multi-country model, however, we examine whether significant foreign asset disequilibrium

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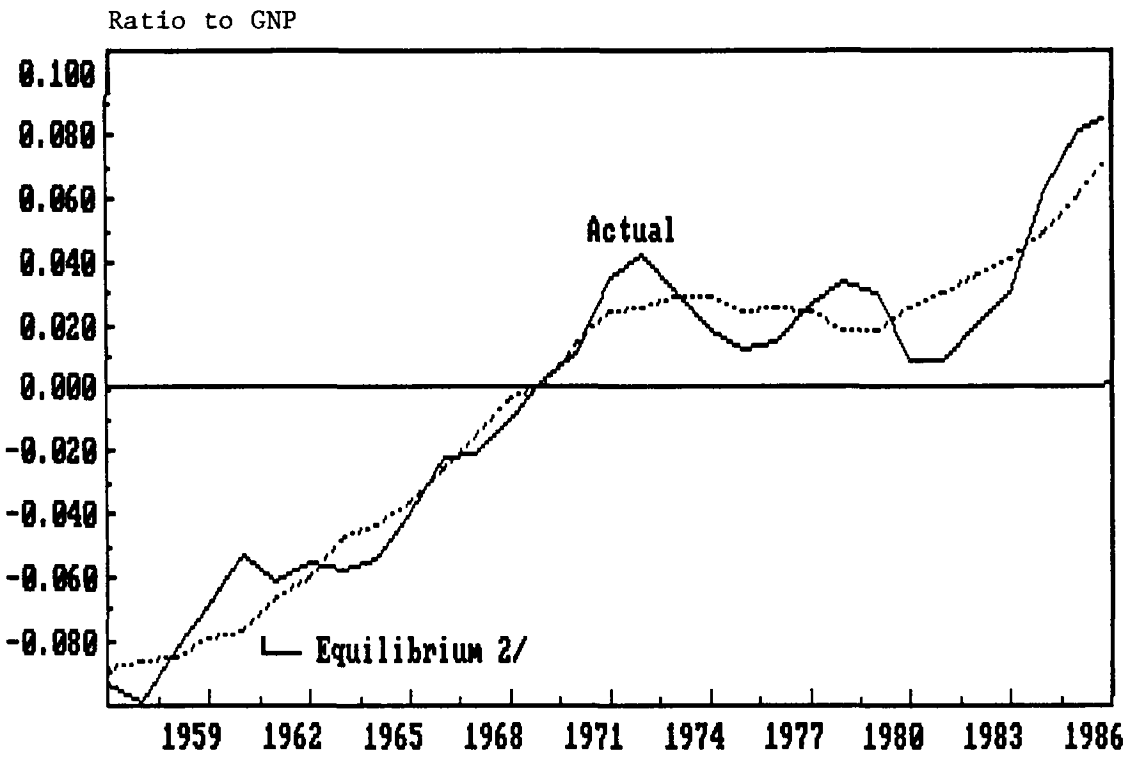
1/ One factor picked up by this trend term may be the relatively strong reliance of the German economy on exports as a source of growth, reflecting, during Bretton Woods, a relatively low inflation target in Germany (Lipschitz and Mayer [1988]), and, more recently, structural rigidities in the domestic economy prompting investment abroad (Lipschitz et al. [1989]).

Chart 4

JAPAN

Actual and equilibrium values of
net foreign assets, 1956-86 1/



Source: Appendix I and Table 2.

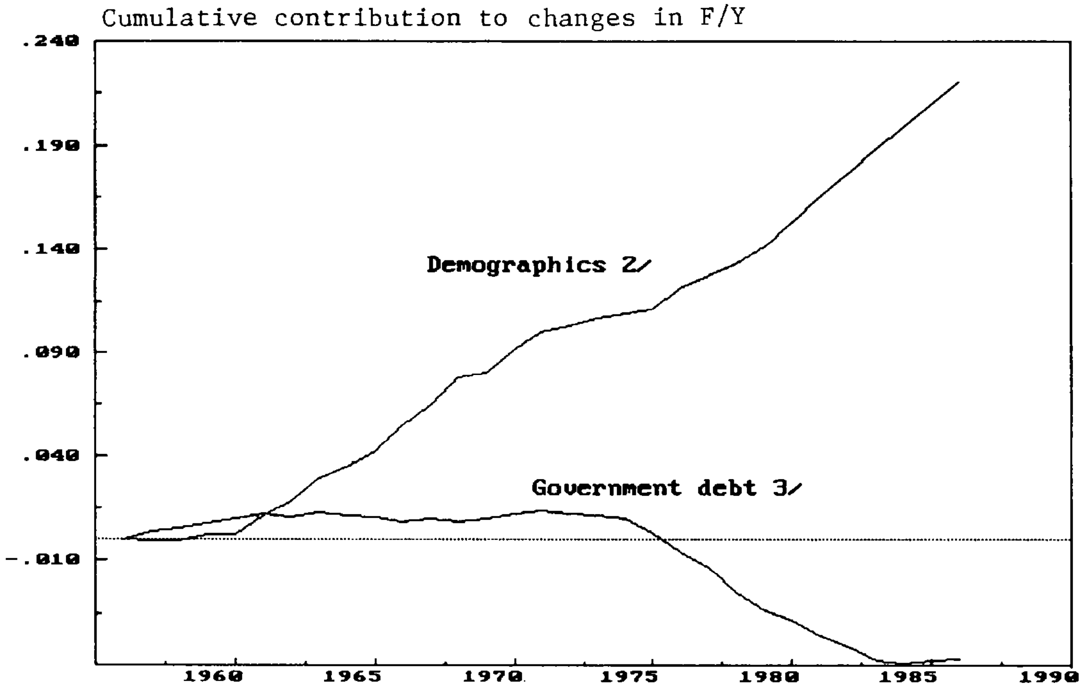
1/ Conditional on demographics and the ratio of government debt to GNP.

2/ Coefficients are in Table 2; determinants are in Chart 5.

Chart 5

JAPAN

The determinants of net foreign asset equilibrium, 1956-86 1/



Source: Table 2.

1/ This chart shows the contribution of demographics and government debt to changes since 1956 in the conditional net foreign asset equilibrium depicted in Chart 4.

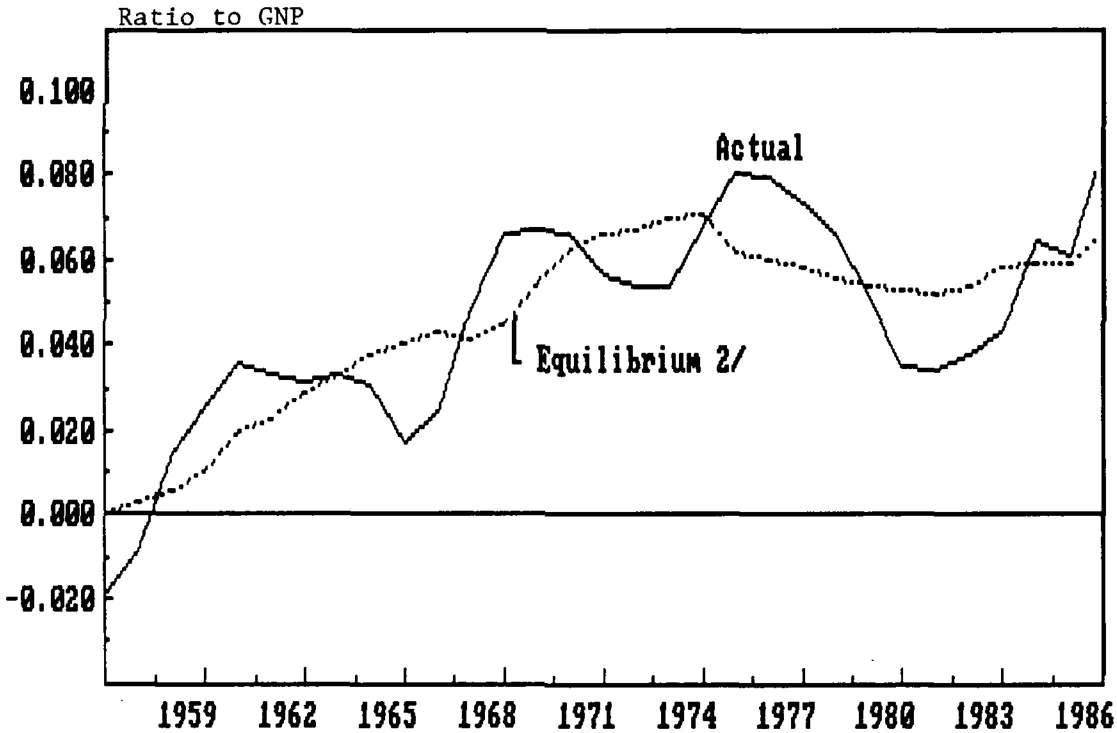
2/ Linear combination of RDEM1 and RDEM2 using the coefficients from Table 2, shifted so that 1956=0.

3/ B/Y multiplied by its coefficient from Table 2, shifted so that 1956=0.

Chart 6

GERMANY

Actual and equilibrium values of net foreign assets, 1956-86 1/



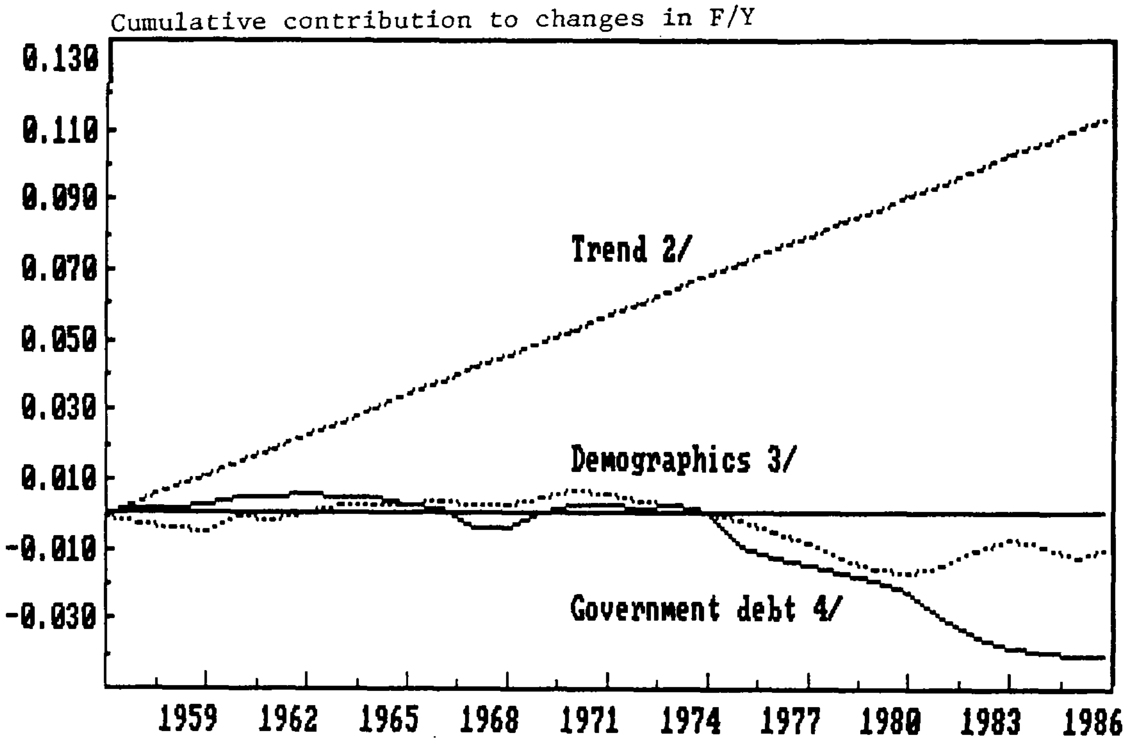
Source: Appendix I and Table 2.

1/ Conditional on demographics and the ratio of government debt to GNP.
2/ Coefficients are in Table 2; determinants are in Chart 7.

Chart 7

GERMANY

The determinants of net foreign asset equilibrium, 1956-86 1/



Source: Table 2.

1/ This chart shows the contribution of demographics and government debt to changes since 1956 in the conditional net foreign asset equilibrium depicted in Chart 6.

2/ Trend term multiplied by its coefficient in Table 2, shifted so that 1956=0.

3/ Linear combination of RDEM1 and RDEM2 using the coefficients from Table 2, shifted so that 1956=0.

4/ B/Y multiplied by its coefficient from Table 2, shifted so that 1956=0.

feedback is discernible in selected structural equations of the model. In order to be able to distinguish between different channels of feedback, we transform (14) so as to arrive at a semi-reduced form equation for foreign assets conditional both on foreign asset disequilibrium and on several variables usually present in models of the current account, particularly domestic and foreign absorption, and the real exchange rate. The choice of this specification is motivated by the desire to identify "expenditure changing" channels (through the possible influence of changes in net wealth on relative absorption) and "expenditure-switching" channels (through the real exchange rate). Hence, the disequilibrium feedback term in this equation may be interpreted as capturing other channels that may be significant empirically (for example, supply side effects and non-price competitiveness factors such as non-tariff barriers, which are not modeled explicitly). 1/

The common specification of the dynamic net foreign asset equation estimated for each of the three countries is:

$$\Delta(F/Y) = c_0 - c_1\hat{u}_{-1} - c_2[\ln(A/Y)-\ln(AF/YF)]_{-1} - c_3\ln(RE)_{-1} \qquad (15)$$

The variable $\hat{u}$ represents net foreign asset disequilibrium (the residuals from the cointegration regressions reported in Table 2); A and Y are domestic absorption and GNP, respectively; AF and YF are their foreign equivalents; and RE is the real effective exchange rate (a rise signifying appreciation). 2/ The feedback channel through absorption is subsequently explored further by testing whether the latter is influenced by foreign asset disequilibrium. We do not attempt to model exchange rates, given the lack of success that has plagued other research in this area.

Within the confines of the analytical framework, the choice both of additional explanatory variables and between lag structures was guided mainly by the ability of alternative specifications to satisfy a set of diagnostic tests. In addition to the tests for residual autocorrelation, heteroscedasticity and non-normality which are reported below, each regression was scrutinized for the stability over time of each of its

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1/ It may also pick up mis-specification of the absorption and exchange rate channels (for example, if linkages through components of absorption operate differently).

2/ It was verified that all the variables in the dynamic regressions are I(0). For this sample it appeared to be difficult to reject non-stationarity of the real effective exchange rates of the United States and Japan, but the order of integration of real exchange rates remains controversial (e.g., Glen [1988] shows that, when taking account of residual heteroscedasticity, bilateral real exchange rates of the U.S. dollar against other major currencies are I(0), implying that the U.S. real effective rate may be I(0) as well). For Germany, non-stationarity of the real effective exchange rate can be rejected at a significance level of 10 percent.

estimated coefficients and of its estimated equation standard error. 1/ All regressions are OLS; regressions containing current-dated variables were checked for simultaneity. 2/ The standard errors of the coefficient estimates (reported in parentheses) are heteroscedasticity-consistent (White [1980]).

The main finding of the dynamic analysis is that error correction feedback from foreign asset disequilibrium is highly significant for each of the three countries, both in the equations for net foreign assets and in those for absorption. Moreover, the estimated coefficients on the disequilibrium terms tend to be large, particularly for Japan and Germany. In none of the dynamic equations can the parameter restrictions incorporated in the error correction terms be rejected. The dynamic analysis thus provides strong support for the cointegration findings of the previous section.

a. United States

The estimation of (15) for the United States produced an equation for net foreign assets with statistically significant influences from each of the variables, but the equation failed some of the diagnostic tests. This appeared to be due to the omission of two other dynamic variables, namely the change of the ratio of public debt to GNP and the lagged differential between real interest rates at home and abroad. These variables may reflect mis-specification or mis-measurement of the absorption and real exchange rate channels. For instance, if trade is dominated by goods which are sensitive to interest rates, then the use of aggregate absorption may fail to capture properly the effects on net foreign assets that operate through this channel. The preferred equation was the following:

1/ Parameter stability was checked with the recursive regression feature of PCGIVE, which, starting with the first few observations and ending with the full sample, successively adds one observation and re-estimates the model, offering various graphical assessments of the stability of the estimates (including an extensive series of Chow tests--see Hendry [1989] for a full description).

2/ This was done by treating the current-dated variables as endogenous in a regression estimated by Instrumental Variables, and determining whether the parameter estimates thus obtained differed significantly from those obtained by OLS (this procedure was recommended by Sargan [1958]).

$$\Delta(F/Y) = -\underset{(0.0022)}{0.0014} - \underset{(0.07)}{0.34}\, \hat{u}_{-1} - \underset{(0.05)}{0.43}\, [\ln(A/Y) - \ln(AF/YF)]_{-1} \qquad (16)$$

$$- \underset{(0.007)}{0.014}\, \ln(RE)_{-1} - \underset{(0.06)}{0.14}\, \Delta(B/Y) - \underset{(0.06)}{0.15}\, (R-RF)_{-1}$$

$T = 1957\text{-}86$ $\qquad R^2 = 0.87$ $\qquad \hat{\sigma} = 0.0044$

$AR\ (3,21)_1^3 = 1.57\ (3.07)$ $\qquad AR\ (1,23)_1^1 = 0.04\ (4.28)$

$ARCH\ (2,20) = 0.04\ (3.49)$ $\qquad HET\ (10,13) = 0.65\ (2.67)$

$NORM\ (2) = 0.40\ (5.99)$

The variable R represents the real interest rate at home, and RF is its foreign counterpart. This equation satisfies all the diagnostic tests, and recursive estimation reveals no parameter instability. Chart 8 shows the actual and fitted values. 1/ The error correction variable is quite significant: its t-value is 4.8. An F-test of the parameter restriction incorporated in the error correction variable (testing the joint significance of $(B/Y)_{-1}$, $RDEM1_{-1}$, and $RDEM2_{-1}$) has the value 1.1, which, given the 5 percent critical value of 3.1, clearly validates the estimate of the cointegrating vector obtained in Table 2.

We did not succeed in finding a model for U.S. absorption with stable parameters covering the entire sample period 1957-86, but a satisfactory model for the period until the early 1980s is:

$$\Delta(A/Y) = \underset{(0.15)}{0.66} + \underset{(0.11)}{0.36}\, \hat{u}_{-1} - \underset{(0.15)}{0.66}\, (A/Y)_{-1} - \underset{(0.05)}{0.16}\, R \qquad (17)$$

$T = 1957\text{-}81$ $\qquad R^2 = 0.59$ $\qquad \hat{\sigma} = 0.0036$

$AR\ (3,18)_1^3 = 0.48\ (3.16)$ $\qquad AR\ (1,20)_1^1 = 0.25\ (4.35)$

$ARCH\ (2,17) = 0.14\ (3.59)$ $\qquad HET\ (6,14) = 1.08\ (2.85)$

$NORM\ (2) = 0.79\ (5.99)$

Again, the t-value on $\hat{u}_{-1}$ is large (3.2), and the cointegration restriction is easily satisfied (the F-test is 0.1 against the 5 percent critical value of 3.2). Chart 9 displays the actual and fitted values for 1957-81, as well as the conditional forecasts for 1982-86. Although it passes parameter stability tests prior to 1982, the model subsequently dramatically underpredicts U.S. absorption relative to GNP. The large Federal deficits during the Reagan administration apparently not only raised the public debt to GNP ratio and thus lowered the conditional net foreign asset equilibrium (Chart 2), but, during the same episode, the

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1/ The large residual in 1971 may reflect the sizeable foreign exchange intervention preceding the Smithsonian Agreement, or associated valuation changes incorporated in the net foreign asset data for that year.

ratio of absorption to GNP failed to fall despite low (lagged) net foreign assets, a high (lagged) absorption-to-GNP ratio, and high real interest rates. As far as the public part of absorption is concerned, this apparent change of regime is consistent with the finding of Kremers [1989], that after 1981 high Federal debt interest costs failed to produce deficit reductions in line with the pattern during most of the inter- and postwar period.

b. Japan

The estimated dynamic equation for net foreign assets of Japan is:

$$\Delta(F/Y) = \underset{(0.0015)}{-\,0.0018} \; \underset{(0.15)}{-\,0.71\,\hat{u}_{-1}} \; \underset{(0.16)}{-\,0.48} \,[\ln(A/Y)-\ln(AF/YF)]_{-1} \qquad (18)$$

$$\underset{(0.006)}{-\,0.039}\ln(RE)_{-1} \; \underset{(0.012)}{-\,0.034}\,\Delta\Delta\ln(RE)$$

$$\underset{(0.14)}{+\,0.40}\,\Delta[(B/Y)^{US}_{-1} + (B/Y)^{US}_{-2}]/2$$

T = 1957-86 $R^2 = 0.68$ $\hat{\sigma} = 0.0072$

AR $(3,21)^3_1 = 0.21$ (3.07) AR $(1,23)^1_1 = 0.00$ (4.28)

ARCH (2,20) = 0.91 (3.49) HET (10,13) = 0.23 (2.67)

NORM (2) = 0.11 (5.99)

This equation satisfies all the diagnostic criteria and its parameters seem to be stable; actual and fitted values are in Chart 10. In common with the U.S. results, the error correction term is significantly negative (the t-value is 4.7), and the cointegration restriction can not be rejected (the F-test is 1.6 against a 5 percent critical value of 3.1). The influences of relative absorption and the real exchange rate are also similar to those found for the United States. 1/ One difference is the presence, prompted by an examination of various alternatives, of a foreign (U.S.) rather than domestic public debt variable. A domestic debt variable is already included in $\hat{u}$; as described in Section II, in a symmetric two-country model, foreign debt should also appear (with opposite sign), and the U.S. debt variable may be playing this role.

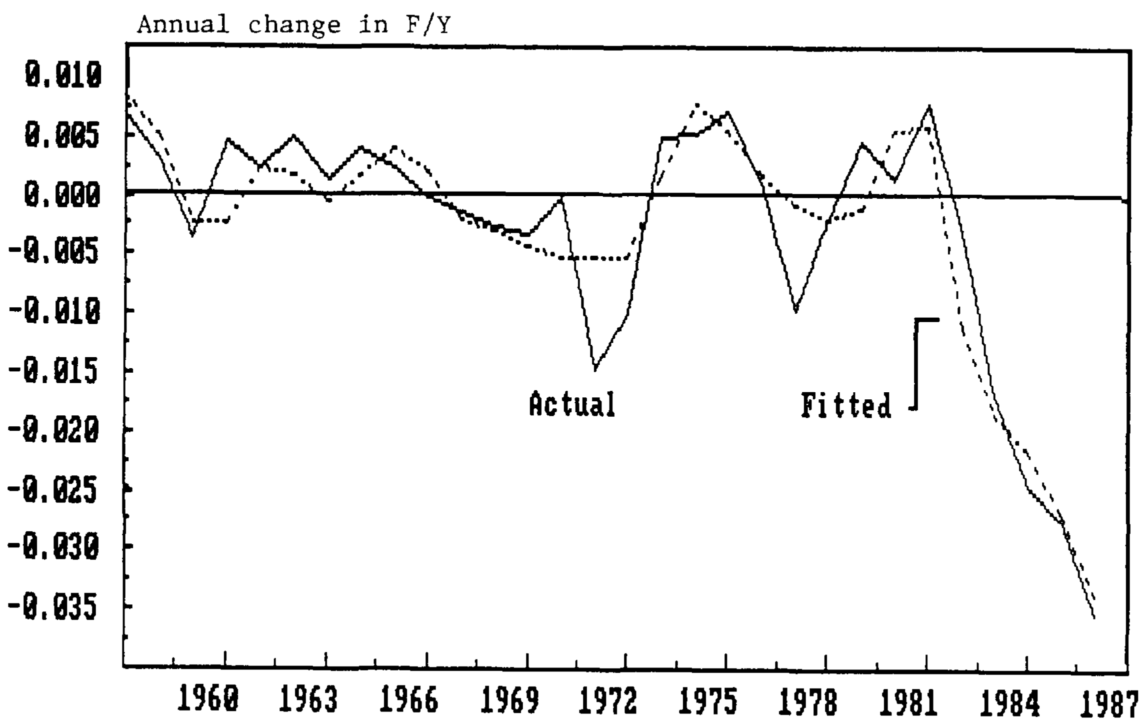
Feedback from foreign asset disequilibrium was found to affect absorption in Japan as well:

1/ The variable representing the acceleration of the real exchange rate is of plausible sign and serves to pick up some of the dynamics; its presence is dictated by the data rather than based on explicit theoretical considerations.

Chart 8

UNITED STATES

Actual and fitted values of the model
for net foreign assets 1/



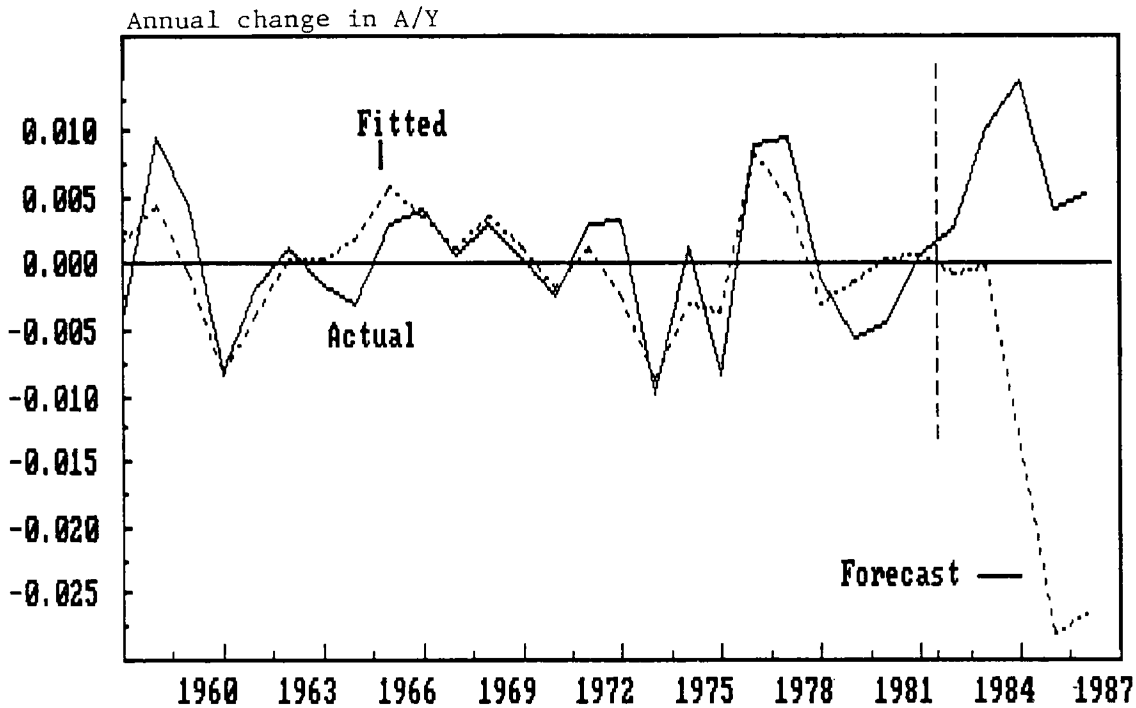
Source: Equation (16).

1/ Estimation period is 1957-86.

Chart 9

UNITED STATES

Actual, fitted and forecast values of the model for absorption 1/



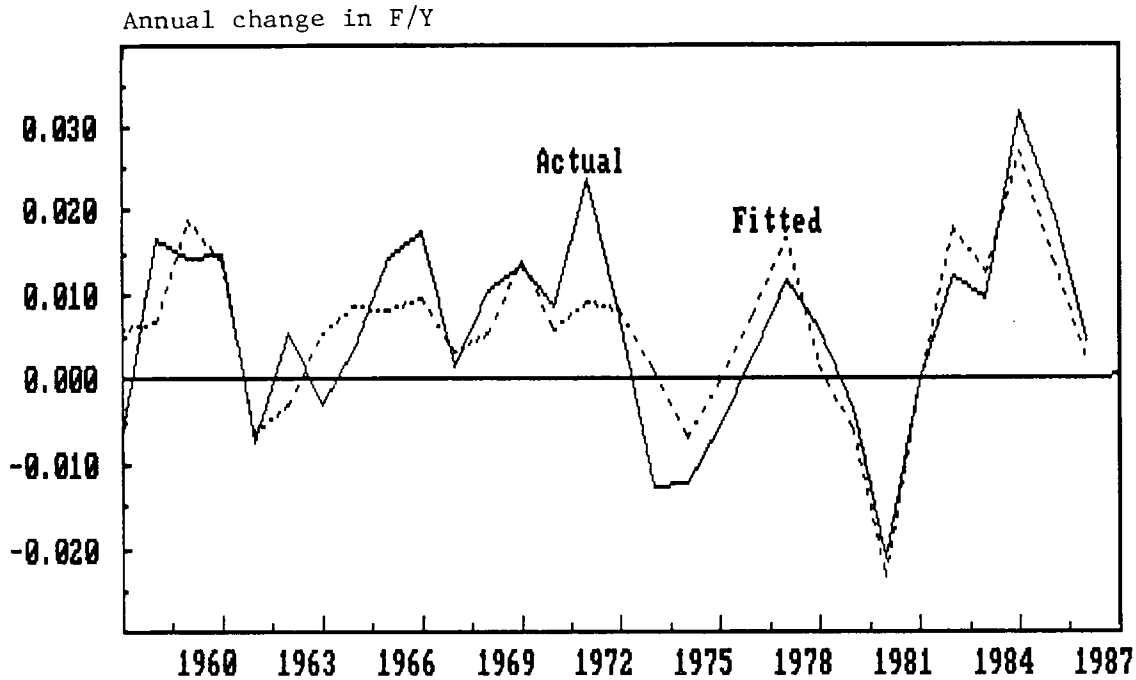
Source: Equation (17).

1/ Estimation period is 1957-81; conditional forecasts for 1982-86.

Chart 10

JAPAN

Actual and fitted values of the model
for net foreign assets 1/



Source: Equation (18).

1/ Estimation period is 1957-86.

$$\Delta(A/Y) = -\underset{(0.0019)}{0.0033} + \underset{(0.15)}{0.56}\,\hat{u}_{-1} - \underset{(0.11)}{0.21}\,\Delta(A/Y)_{-2} \tag{19}$$

$$-\underset{(0.07)}{0.24}\,\Delta R_{-1} + \underset{(0.11)}{0.36}\,\Delta\Delta(B/Y)_{-1} + \underset{(0.07)}{0.19}\,\Delta(B/Y)_{-1}$$

$T = 1957\text{-}87$ $\quad R^2 = 0.68$ $\quad \hat{\sigma} = 0.0082$

$AR\ (3,22)_1^3 = 0.91\ (3.05)$ $\quad AR\ (1,24)_1^1 = 2.98\ (4.26)$

$ARCH\ (2,21) = 0.48\ (3.47)$ $\quad HET\ (10,14) = 0.24\ (2.60)$

$NORM\ (2) = 1.08\ (5.99)$

The t-value on $\hat{u}_{-1}$ is 3.8, and the F-test for the cointegration restriction is 0.8 (the 5 percent critical value is 3.1). This is the preferred equation for Japanese absorption conditional on the set of variables involved in this study. It passes the reported tests, the estimated equation standard error appears to be stable, and its tracking performance is satisfactory (Chart 11), but, in the earlier part of the sample, some of the coefficient estimates exhibit signs of instability. However, the apparent instability seems to affect neither the signs of any of the coefficient estimates nor the inference regarding feedback from foreign asset disequilibrium.

c. Germany

The net foreign asset equation for Germany is essentially similar to those for the United States and Japan, except that two variables were added to capture some of the dynamic effects of large terms-of-trade changes that have resulted especially from oil price changes: 1/

$$\Delta(F/Y) = -\underset{(0.002)}{0.010} - \underset{(0.07)}{0.60}\,\hat{u}_{-2} - \underset{(0.06)}{0.59}\,[\ln(A/Y) - \ln(AF/YF)]_{-1} \tag{20}$$

$$-\underset{(0.015)}{0.065}\,\ln(RE)_{-1} - \underset{(0.03)}{0.15}\,\Delta\Delta\ln(A)$$

$$+\underset{(0.026)}{0.052}\,\Delta\Delta\ln(EUV)_{-1} + \underset{(0.004)}{0.014}\,\Delta\ln(EUV/POIL)_{-1}$$

$T = 1958\text{-}87$ $\quad R^2 = 0.90$ $\quad \hat{\sigma} = 0.0046$

$AR\ (3,19)_1^3 = 0.90\ (3.13)$ $\quad AR\ (1,21)_1^1 = 0.51\ (4.32)$

$ARCH\ (2,18) = 0.77\ (3.55)$ $\quad HET\ (12,10) = 0.67\ (2.91)$

$NORM\ (2) = 0.84\ (5.99)$

1/ The regression also included a dummy variable for 1985; in that year the growth rate of German net foreign assets fell sharply as a result of valuation losses due to the appreciation of the U.S. dollar (Chart 12).

The variable EUV represents an index of German export unit values and POIL is the price of oil (both in deutsche mark). The diagnostic tests are satisfied and the parameter estimates appear stable. The t-value for net foreign asset disequilibrium feedback is very high (8.6), and, at a value of 0.7, an F-test cannot reject the cointegration restriction (the 5 percent critical value is 2.9). Actual and fitted values are in Chart 12.

Finally, feedback from foreign asset disequilibrium is also identified as a determinant of absorption in Germany:

$$\Delta(A/Y) = \underset{(0.002)}{-\ 0.006} + \underset{(0.12)}{0.72}\ \hat{u}_{-2} - \underset{(0.14)}{0.60}\ \Delta(A/Y)_{-2} \qquad (21)$$

$$- \underset{(0.14)}{0.53}\ \Delta\Delta R + \underset{(0.05)}{0.17}\ \Delta\ln(M1)_{-1}$$

$T = 1963\text{-}87 \qquad R^2 = 0.76 \qquad \hat{\sigma} = 0.0068$

$AR\ (3,17)_1^3 = 0.48\ (3.20) \qquad AR\ (1.19)_1^1 = 0.86\ (4.38)$

$ARCH\ (2,16) = 1.03\ (3.63) \qquad HET\ (8,11) = 0.25\ (2.95)$

$NORM\ (2) = 0.70\ (5.99)$

The variable M1 represents the M1 money stock, divided by the GNP deflator. 1/ In the case of Germany, it appears to be appropriate to express both A and Y in constant prices (they were divided by their respective price deflators). The t-value on $\hat{u}_{-2}$ is high (6.2), and the F-test for the cointegration restriction is 0.7 against the 5 percent critical value of 3.0. The tracking performance of this equation is displayed in Chart 13.

V. Conclusions

This study has sought to confirm the presence of stabilizing mechanisms for the current account positions of the three largest industrial countries in the post-World War II period. Persistent and large current account imbalances have led to quite dramatic changes in the net international positions of the United States, Japan, and Germany. However, various feedback effects from foreign asset stocks onto variables such as domestic absorption, real exchange rates and real interest rates may act as stabilizing mechanisms to prevent a continued increase of these net foreign asset or liability positions, and to ensure an eventual return to long-run equilibrium.

A theoretical model of optimizing consumers was specified in which long-run net foreign asset equilibrium, relative to GNP, was shown to be related, inter alia, to government debt. Cointegration tests were used to

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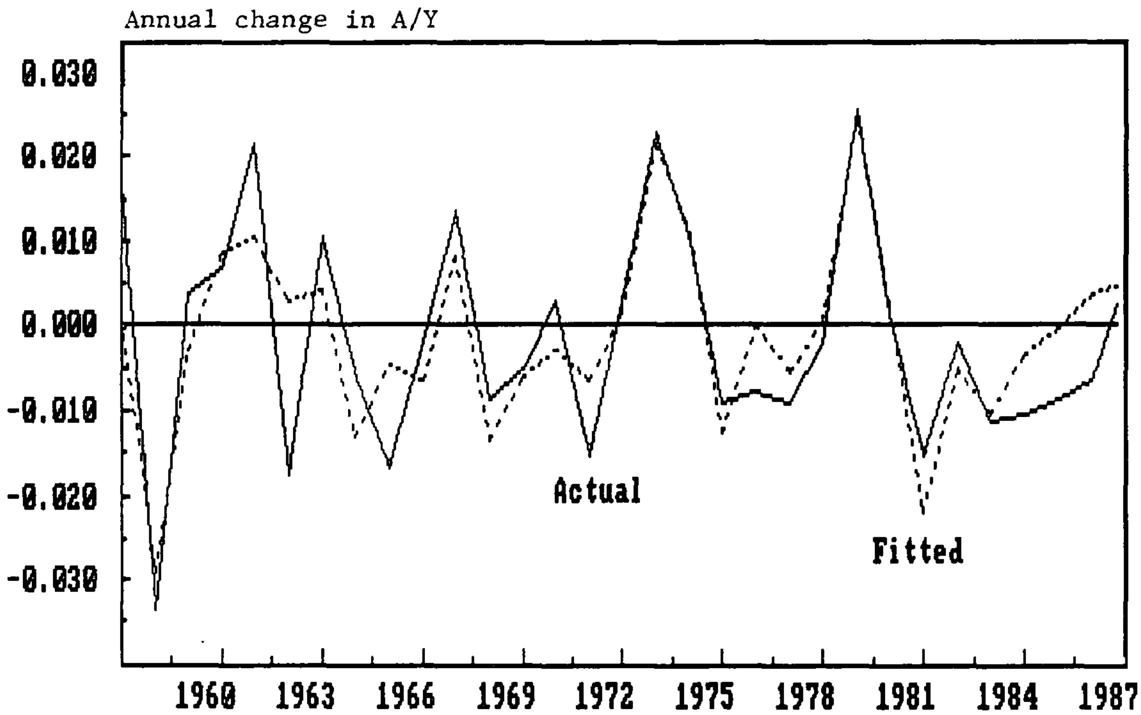
1/ The interest rate is in nominal terms.

Chart 11

JAPAN

Actual and fitted values of the model for absorption 1/



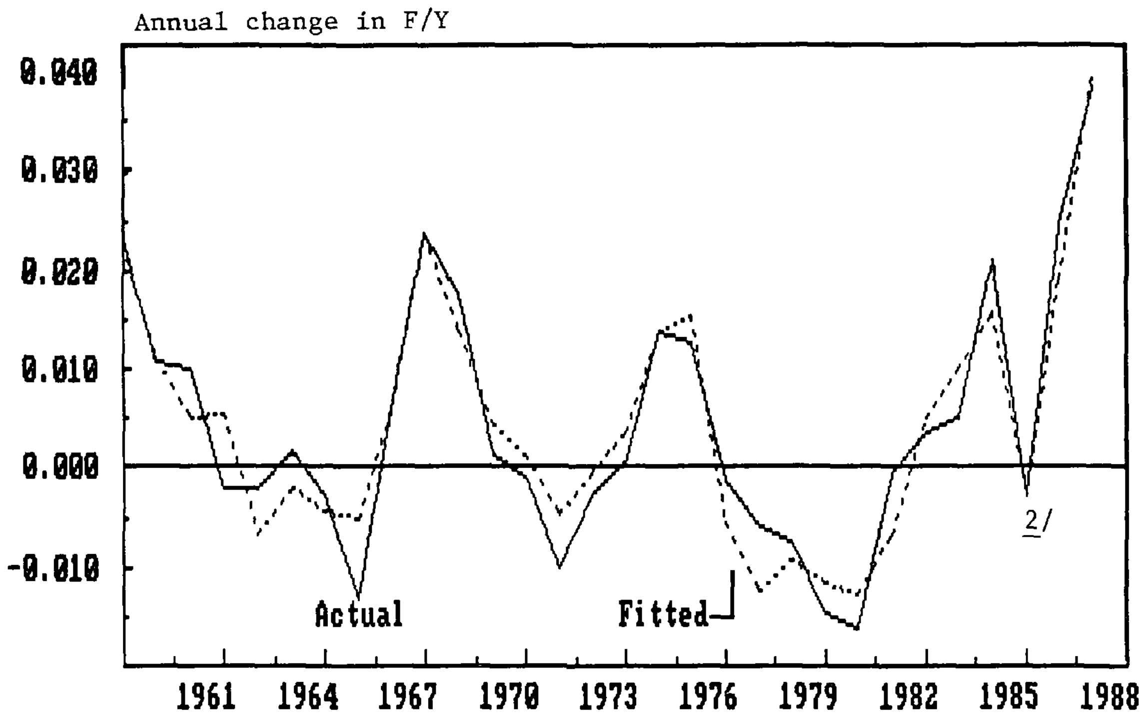
Source: Equation (19).

1/ Estimation period is 1957-87.

Chart 12

GERMANY

Actual and fitted values of the model
for net foreign assets 1/



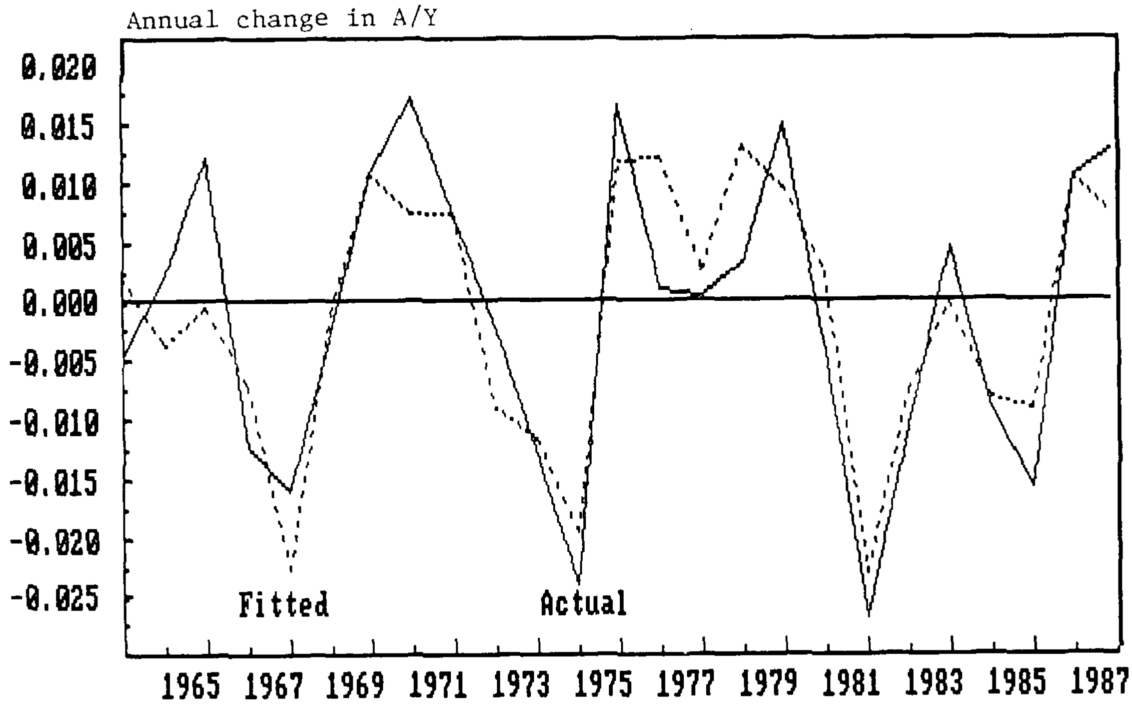
Source: Equation (20).

1/ Estimation period is 1958-87.
2/ Dummy variable included for 1985.

Chart 13

GERMANY

Actual and fitted values of the model
for absorption 1/



Source: Equation (21).

1/ Estimation period is 1963-87.

investigate empirically the nature of the long-run equilibrium relationship for the United States, Japan and Germany using postwar data. These tests suggest the existence of a long-run relationship between the net foreign asset/GNP ratio, the public debt/GNP ratio, and demographic factors.

Dynamic error correction models for net foreign assets and domestic absorption provide strong support for the inference based on the cointegration tests: in each of the three countries deviations from the long-run equilibrium net foreign asset ratio appear to exercise significant, stabilizing feedback on current account imbalances through domestic absorption and other channels. Dynamic equations for net foreign assets of the United States, Japan and Germany as well as equations for absorption in Japan and Germany satisfy a broad set of diagnostic criteria, including tests for parameter stability. However, a model for U.S. absorption based upon data covering most of the postwar period satisfies the requirement of parameter stability only prior to the 1980s. After 1981, it predicts values of domestic absorption significantly lower than those actually recorded.

Developments in the 1980s therefore seem to have differed between the United States on the one hand and Japan and Germany on the other hand in two respects. First, the conditional long-run net foreign asset equilibrium of the United States swung very sharply negative, reflecting an accumulation of public debt at a pace so rapid that it represented a break with the policies of previous decades. In contrast, the Japanese and German authorities implemented policies to consolidate the public finances, and the net foreign assets of these countries increased strongly. Second, the dynamic behavior of U.S. absorption that prevailed during most of the postwar period changed significantly in the 1980s, giving rise to an historically high level of absorption relative to income. In contrast, no such behavioral changes seem to have taken place in Japan or Germany. Nevertheless, the further evolution of developments in the United States may naturally have repercussions for other countries, including Japan and Germany, even if these countries have not as yet experienced any significant behavioral changes themselves.

Against that background, it will be of interest to extend this research by analyzing in greater detail the various foreign asset feedback mechanisms. 1/ Specifically, a more profound understanding of the issues raised in the previous paragraph may result from a breakdown of absorption into public and private components.

The empirical findings also have some bearing on the issue of the correlation between saving and investment. The analysis of this paper may be viewed as the stock analog of recent contributions by Feldstein and Horioka [1980] and others on international saving-investment flows.

1/ Some unreported preliminary regressions indicated that real interest rates are influenced by net foreign asset positions; this suggests the empirical relevance of an additional feedback channel, namely the possibility of risk premium effects on relative returns.

Evidence of net foreign asset feedback may help explain why time series data show a high correlation between saving and investment. A shock to either saving or investment, by leading to an accumulation of foreign assets or liabilities, will bring about forces that tend to feed back onto absorption and output, in such a way that over time the effect of the shock is reversed. The faster these mechanisms operate, the less likely is the emergence of large current account surplus and deficit positions.

Data Sources

This Appendix provides the sources of data used in this study; the data are available from the authors.

1. Net foreign assets (F)

United States: Stock data defined as total U.S. investments abroad minus total foreign investments in the United States (billions of U.S. dollars). Sources: data for 1950-69 from Historical Statistics of the United States, Colonial Times to 1970, U.S. Department of Commerce; data for 1969-86 from Survey of Current Business (June issues), U.S. Department of Commerce. Gold netted out from both series using IFS gold series (line 1a,n,d).

Japan: 1956-70: stock data derived by decumulating current account balances from the 1971 value (in billions of yen) of net foreign assets. Sources: current account balances (1965-1970) from IMF World Economic Outlook, and K. Ohkawa, Estimates of Long-Term Economic Statistics of Japan Since 1868, National Income, Vol. 1; 1971-86: stock data from Bank of Japan Balance of Payments Monthly (converted from millions of U.S. dollars at end-of-period exchange rates). Gold netted out using IFS series (line 1a,n,d).

Germany: Stock data defined as external assets less liabilities (billions of deutsche mark). Source: Monthly Report, Deutsche Bundesbank. Gold netted out using same source.

2. Gross national product (Y)

Source: IMF World Economic Outlook (WEO) databank. (For Germany, data prior to 1960 multiplied by 303/286 in order to compensate for the absence in the data of Saarland and Berlin.)

3. Foreign gross national product (YF)

The aggregate nominal GNP of 13 other industrial countries (valued at current exchange rates). Source: as for (2).

4. Domestic absorption (A)

Nominal gross national product minus nominal exports plus nominal imports. Source: IMF WEO databank.

5. Foreign absorption (AF)

The aggregate domestic absorption of other industrial countries (valued at current exchange rates). Source: as for (4).

6. Net government debt (B)

United States: Central government debt less central bank holdings. Source: IFS, line 88.

Germany: Public authorities' total indebtedness. Source: Monthly Report, Deutsche Bundesbank.

Japan: Net liabilities of general government sector. Source: Annual Report on National Accounts, Japan Economic Planning Agency.

7. Real effective exchange rate (RE)

Nominal trade-weighted effective exchange rate with 15 industrial partner countries, deflated by consumer price indices (1980 = 100). Source: IFS and staff calculations.

8. Real interest rate (R)

Long-term interest rate minus a weighted average of annual inflation in the current quarter and in the following two quarters. Source: IFS and staff calculations.

9. Foreign real interest rate (RF)

Trade-weighted sum of real interest rates (as in (8)) of industrial-country trading partners.

10. Demographic variable (RDEM1)

Ratio of the young (under 15 years) to working-age (15-64 years) population for partner countries divided by corresponding ratio for domestic country (total country group: United States, Japan, Germany, Canada, and United Kingdom). Sources: Historical Statistics of the United States, Colonial Times to 1970; Japan Statistical Yearbook; OECD Labor Force Statistics; and Data Resources Inc.

11. Demographic variable (RDEM2)

Ratio of the old (65 years and over) to working-age population for partner countries divided by corresponding ratio for domestic country. Sources: as for RDEM1.

12. Additional data for Germany

a. Price deflators for domestic absorption and GNP: National accounts.
b. *Export unit value index:* IFS, *line 74.*
c. Price of oil: based on export unit values of oil exporting countries. Source: IMF Datafund.
d. Exchange rate of deutsche mark vis-à-vis U.S. dollar: IFS, line rf.
e. Money stock M1: Monthly Report, Deutsche Bundesbank.

Test Statistics

This Appendix contains brief descriptions of the reported diagnostic tests, with degrees of freedom in brackets. The methodological background of these tests can be found in Hendry [1987] and Spanos [1986]. In the text, each reported statistic is followed (in brackets) by its 5 percent critical value.

Autocorrelation

$AR\ (n,.)_i^j$ = Lagrange Multiplier test for residual autocorrelation from lags i to j (j-i+1=n), F-form (see Spanos [1986, p. 521]). Computed by regressing the residuals on all the regressors of the original model and the lagged residuals for lags i to j, and testing the joint significance of the latter.

Heteroscedasticity

ARCH (n,.) = Lagrange Multiplier test for n-th order AutoRegressive Conditional Heteroscedasticity, F-form (see Spanos [1986, p. 548]). Computed by regressing the squared residuals on the lagged squared residuals up to lag n, and testing their joint significance.

HET (.,.) = Lagrange Multiplier test for heteroscedasticity associated with squares of the explanatory variables (see White [1980]). Computed by regressing the squared residuals on the original regressors and their squares, and testing their joint significance.

Normality Residuals

NORM (2) = χ^2-test (see Spanos [1986, p. 454]). Based on the estimated skewness and kurtosis of the residuals compared to their counterparts for the normal distribution.

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